BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H05K 7/20, 5/02

A1

(11) International Publication Number: WO 97/47167

(43) International Publication Date: 11 December 1997 (11.12.97)

(21) International Application Number: PCT/NZ97/00071

(22) International Filing Date: 4 June 1997 (04.06.97)

(30) Priority Data:
286724 4 June 1996 (04.06.96) NZ

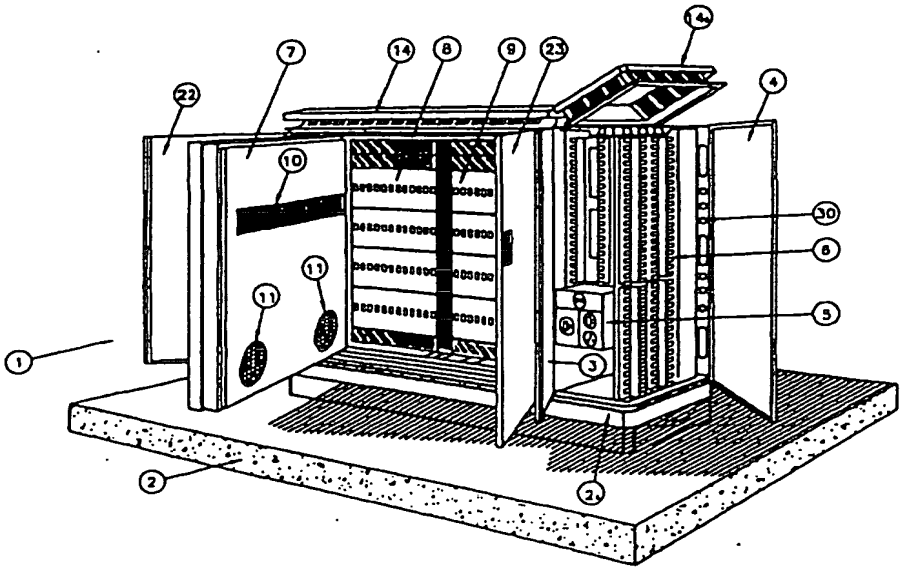
(71)(72) Applicant and Inventor: HOBDAY, David, Stephen [NZ/NZ]; 12 Onedin Place, Titirangi, Auckland (NZ).

(74) Agents: HAWKINS, Michael, Howard et al.; Baldwin, Son & Carey, NCR Building, 342 Lambton Quay, Wellington (NZ).

(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: COOLING SYSTEM FOR EQUIPMENT ENCLOSURE



(57) Abstract

An equipment enclosure for electrical or electronic equipment (1) has a door (7) which can close off the interior chamber (8). The door (7) is fitted with a heat exchanger having separate internal and external air circuits with the internal air circuit connected with the interior chamber (8) and the external air circuit connected for a supply of entering air and for the exhaust of air outside of the enclosure (1). The heat exchanger enables the temperature within the chamber (8) to be kept at a required level relative to the ambient temperature external of the enclosure (1).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

COOLING SYSTEM FOR EQUIPMENT ENCLOSURE

BACKGROUND OF INVENTION

The present invention relates to improvements in and relating to enclosures and more especially to an enclosure or cabinet which is intended for use in accommodating electrical and electronic equipment, especially telecommunications equipment and protecting it from the external environment.

Telecommunications equipment is frequently required to be installed in remote areas and out of doors so that the equipment needs to be protected from the external environment for a substantial period of time and possibly without any maintenance being available.

As telecommunications equipment can generate a substantial amount of heat during operation, a particular problem is to be able to protect the equipment from the external environment while allowing that heat to be dissipated.

It is, thus, an object of one embodiment of the invention to provide an enclosure for electrical or electronic equipment including a thermal management capability which will overcome disadvantages in such enclosures available to the present time or which at least will provide the public with a useful choice.

Further objects of this invention will become apparent from the following description.

BRIEF SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is thus provided an enclosure having at least one interior chamber adapted to accommodate in use electrical or electronic equipment, a door provided for said enclosure and adapted to close off said interior chamber, said door being provided with a heat exchanger means having separate internal and external air circuits, said internal air circuit connected with said interior chamber and said external air circuit connected for air entry and exhaust outside of said enclosure, said heat exchanger means enabling the temperature within said interior chamber to be maintained at a required level relative to the ambient temperature external of the enclosure while maintaining the interior chamber closed.

According to a further aspect of the present invention, there is provided a method of temperature control for an enclosure having at least one interior chamber, said method comprising providing a door closing off said interior chamber, providing separate internal and external air circuits for a heat exchanger provided for said door, connecting said internal air circuit with said interior chamber and said external air circuit for air entry and exhaust outside of said enclosure, said heat exchanger controlling the temperature within said interior chamber to be at a prescribed level relative to the ambient temperature external of said enclosure while maintaining the interior chamber closed.

According to a still further aspect of the present invention, there is provided an enclosure and/or a method of controlling temperature in an enclosure substantially as herein described and/or with reference to the accompanying drawings.

Further aspects of this invention which should be considered in all its novel aspects will become apparent from the following description given by way of example of possible embodiments thereof and in which reference is made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: Shows diagrammatically an enclosure according to one possible embodiment of the invention;

Figure 2: Shows a front view of the enclosure of Figure 1 but without its front cabinet doors;

Figure 3: Shows a side view of the enclosure of Figure 2;

Figure 4: Shows diagrammatically a front view of the enclosure of the preceding figures with its doors closed;

Figure 5A: Shows very diagrammatically a plan view of the enclosure from roof level to illustrate the air flows;

Figure 5B: Shows very diagrammatically a cross sectional plan view of the enclosure below the horizontal divider on the front door to illustrate the air flows;

Figure 5C: Shows very diagrammatically an end view into the distribution framework area to illustrate the air flows;

Figure 6: Shows diagrammatically an enclosure mounting rail for use in the enclosure of the present invention;

Figure 7: Shows diagrammatically the inner equipment enclosure with the distribution frame enclosure connected to it.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the accompanying drawings, an enclosure or cabinet according to one possible embodiment to the invention is referenced generally by arrow 1. It is shown mounted on a concrete plinth 2 which will typically house a battery installation, although alternatively, an above ground battery module may be provided and be adapted to be connected with the cabinet 1. The right hand side of the enclosure 1 is shown provided with the pair of doors 3, 4 which when opened as shown in Figure 1 provide access to battery and power inputs 5 and telecommunications hardware referenced generally by arrow 6.

Interior door 7, provides a closure for a main interior chamber 8 accommodating telecommunications distribution equipment and the like referenced generally by arrow 9.

In Figures 1, 2, 3 and 5, the door 7 is shown provided with an internal air circuit, indicated by air flow arrows A, comprising inlets 11, each suitably with a fan, and at least one outlet 10, so that air can be drawn in from and returned to the interior chamber 8 via a heat exchanger 15 provided for the door 7. An external air circuit is shown by arrows B with external air drawn into the front top of the heat exchanger 15 suitably by fans 12 to exit, after cooling the air in the internal air circuit, at the bottom of the heat exchanger 15.

The heat exchanger 15 may be of any suitable air to air type typically using a labyrinth of heat exchange plates defining the air flow paths and across which thermal transfer occurs.

A roof 14 provides inlet and outlet paths for the external air circuit, as illustrated by the arrows showing air flow through the enclosure 1. It will be appreciated that by having the air inlet and air outlet flows at the top of the enclosure 1 the enclosure is still functional even if it were substantially submerged, watertight seals being provided throughout the enclosure 1 (not shown) to further provide for this submerged operation capability.

As shown in Figure 1, a part 14A of the roof 14 may be wholly or partially lifted if required to facilitate access in to the distribution frame area 6. Part 14A may be pivoted through 180° to lie flat on the remainder of the roof 14.

As shown in particularly in Figure 2 the enclosure 1 may be provided with a plurality of mounting rails 16 which enable the inner equipment chamber to be slid into the external enclosure.

It is envisaged that the enclosure 1 of the present invention may operate in external ambient temperatures of high temperatures up to possibly of the order of 60°C. It is envisaged that at higher ambient temperatures, an air-conditioning module may be also included.

In operation, the telecommunications equipment may typically require the dissipation of up to 2,000 watts. As will be appreciated from the air flow paths indicated in Figures 2, 3 and 5 of the drawings especially, described in more detail below, this dissipation is achieved by the circulation of air within the chamber across the equipment and through the air to air heat exchanger 15 mounted in the door 7.

As described, the heat exchanger 15 will suitably have independent internal and external air circuits through which the air is forced by fans, two fans being shown in Figures 2 and 3 for the inlet and exhaust circuits. The fans may suitably be variable speed allowing for the cooling provided by the exchanger to be adjusted to the relevant internal and external conditions.

Suitably the exchanger 15 may be able to maintain an internal chamber temperature below 45°C with an external ambient temperature of up to 35°C. It is anticipated that generally the temperature of the chamber may be held at between 5-10°C above ambient temperature.

The exhaust air from the heat exchanger 15 is circulated between the inner chamber and the outer skin of the enclosure 1. With the downward flow of the air shown in Figures 2 and 3 particularly this has the added advantage of providing an air pressure at the base of the enclosure 1 which can act as a deterrent to the intrusion of insects and the like while also acting to maintain the base of the enclosure 1 dry.

It will be appreciated that in an air to air heat exchanger, only one third to one fifth of the thermal capacity of the air passing through the exchanger can be used to cool the equipment chamber. As this results in only a small temperature increase of the air exiting the exchanger over ambient temperature, the remaining thermal capacity of the exhaust air can be used to remove solar gain. This solar gain however can also be dealt with by a reflective coating provided for the enclosure 1 and also by insulation provided on the inside of the enclosure 1.

Referring particularly to Figures 2 and 5C, the heat exchanger 15 includes air flow divider means 15C which can direct a portion, perhaps 30-40% of the air of the external air circuit, to pass through the communications area 6 via vents 30 as indicated by the arrows C to remove solar gain.

The air flow divider means 15A, 15B primarily, however, separates the air flow paths including providing a horizontal divider 15B to separate the inlet external air from the air flow in the heat exchanger itself and a divider 15A to separate flow paths in to the heat exchanger 15. The dividers 15A, 15B and 15C may suitably be sheets of an air impervious plastics such as polyethylene foam.

As shown in Figure 4 particularly, front doors 22 and 23 can be secured in front of the internal door 7 to seal off the inside of the enclosure 1 and to define the cavity in front of the heat exchanger 15 through which the exhausting air of the external air circuit is able to travel.

The balance of the external circuit air passes downwardly into the battery compartment 2a and out into the distribution area 6. This air having been warmed by the heat exchanger 15 causes both the battery compartment 2a and the distribution area 6 to be kept free of condensation. Further, should through flood the battery area 2a become filled with water, over a short period the water will be evaporated.

Figures 5A, 5B and 5C further illustrate the air flow paths created to, from and within the enclosure 1, including both the main chamber 8 and the area 6. The air flow arrows use the electrical notation of a dot representing flow out of the page and a cross for flow into the page. Referring firstly to Figure 5A, at roof level, the incoming air flow for the left fan is referenced L while that for the right fan is referenced R, divider 15A keeping those flows separate. This enables one fan 12 to be stopped whenever required resulting in the fan 12 still running causing a reverse flow of air over the area of the roof 14 providing the stopped fan's inlet cleaning off any leaves or other debris which may have accumulated. This may be done automatically by a suitable program on the central processing unit. Air flow is then created down the front of the door 7, indicated by D into the fans 12. The exhaust air rising through the area 6 is indicated by U and the outgoing exhaust air is represented by E. Figure 5B shows the air flows below the horizontal divider with air flow S generated by the left hand fan sweeping away solar gain from

the front, side and back of the cabinet 1 before entering area 6. The downward air flow D generated by the right hand fan dries the base of the cabinet 1 and rises under the area 6 to keep it dry. In Figure 5C, the air flow C is shown exiting the back panel through holes 30 into the area 6.

In Figure 5A, a further divider 31, suitably also of polyethylene foam, or the like, is shown positioned on the roof 14 to divide the inlet and exhaust air paths.

As mentioned previously, the enclosure 1 may be mounted on mounting rails 16. As shown in Figure 6, each rail 16 may include a base rail 17 with an enclosure mounting channel 18. A pair of wedges 19 of nylon for example may be positioned on either side of the base rail 17 with a clamping bolt 20 holding the assembly together. A stop (not shown) may be suitably provided at the rear of the base rail 17.

As shown in Figure 7, the distribution frame enclsoure 6 can be bolted by bolts 32 to the inner equipment enclosure 8 so as to move with it. In this way, as the required size of the distribution frame needs to grow with future expansion, an expanded distribution frame can be readily accommodated.

Where in the foregoing description reference has been made to specific components or integers of the invention having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof it is to be understood that modifications or improvements may be made thereto without departing from the scope or spirit of the invention, as defined in the appended claims.

I CLAIM:

1. An enclosure having at least one interior chamber adapted to accommodate in use electrical or electronic equipment, a door provided for said enclosure and adapted to close off said interior chamber, said door being provided with a heat exchanger means having separate internal and external circuits, said internal air circuit connected with said interior chamber and said external air circuit connected for air entry and exhaust outside of said enclosure, said heat exchanger means enabling the temperature within said interior chamber to be maintained at a required level relative to the ambient temperature external of the enclosure while maintaining the interior chamber closed.

2. An enclosure as claimed in Claim 1 wherein said internal air circuit includes one or more inlets provided in said door connected with at least one outlet in said door, a suction means operable to cause air flow between said inlets and said outlets through said heat exchanger.

3. An enclosure as claimed in Claim 2 wherein said external air circuit includes at least one inlet in said door and suction means to draw external air through said inlet(s) to cool the air in the internal air circuit.

4. An enclosure as claimed in Claim 3 and including air inlet and air outlets paths for the external air circuit at an upper portion of said enclosure.

5. An enclosure as claimed in Claim 4 and provided with mounting rails to enable the enclosure to be slid into and from an external housing.

6. An enclosure as claimed in Claim 3 wherein the suction means provided for said internal and external air circuits comprises one or more variable speed fans.

7. An enclosure as claimed in Claim 1 wherein exhaust air from the heat exchanger is circulated between the interior chamber and an outer surface of the enclosure.

8. An enclosure as claimed in Claim 7 wherein the external air circuit provides for a downward flow of air towards the base of the enclosure to provide increased air pressure at the base of the enclosure.

9. An enclosure as claimed in Claim 1 and including an air flow dividing means to direct a portion of the air of the external air circuit to be directed towards another chamber to remove solar gain therefrom.

10. An enclosure as claimed in Claim 9, wherein a further dividing means is provided at an upper portion of said enclosure so as to provide at least two separate inlet air flow paths.

11. An enclosure as claimed in Claim 10 wherein each said separate inlet air flow path is connected with a respective fan means and wherein the termination of operation of one of said fan means enables the other said fan means to provide a reverse flow of air to clear debris from the other of the inlet air flow paths.

12. An enclosure as claimed in Claim 5 wherein a distribution framework is provided as part of, and is moveable, with said enclosure.

13. An enclosure substantially as herein described with reference to the accompanying drawings.

14. A method of temperature control for an enclosure having at least one interior chamber, said method comprising providing a door closing off said interior chamber, providing separate internal and external air circuits for a heat exchanger provided for said door, connecting said internal air circuit with said interior chamber and said external air circuit for air entry and exhaust outside of said enclosure, said heat exchanger controlling the temperature within said interior chamber to be at a prescribed level relative to the ambient temperature external of said enclosure while maintaining the interior chamber closed.

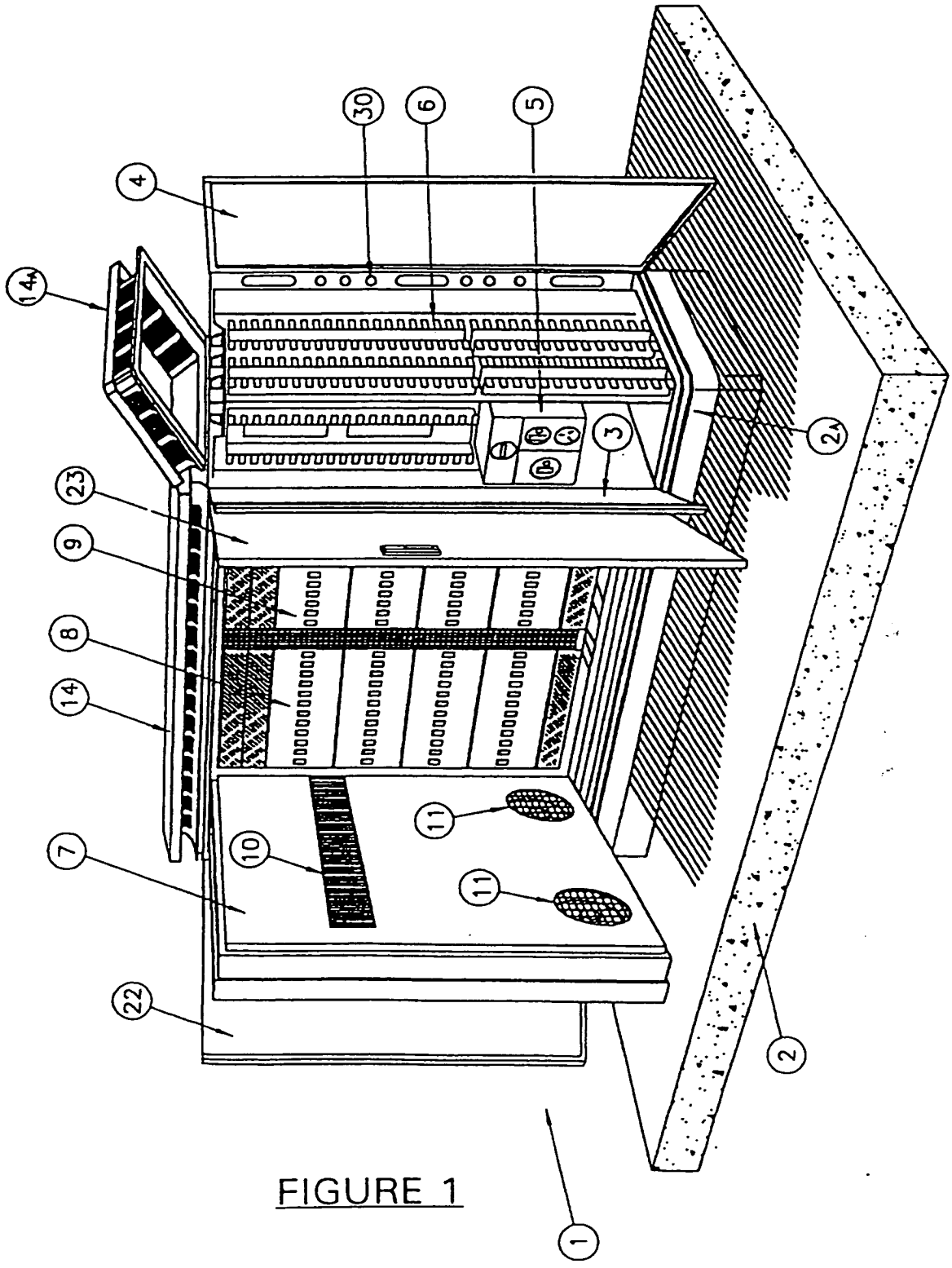


FIGURE 1

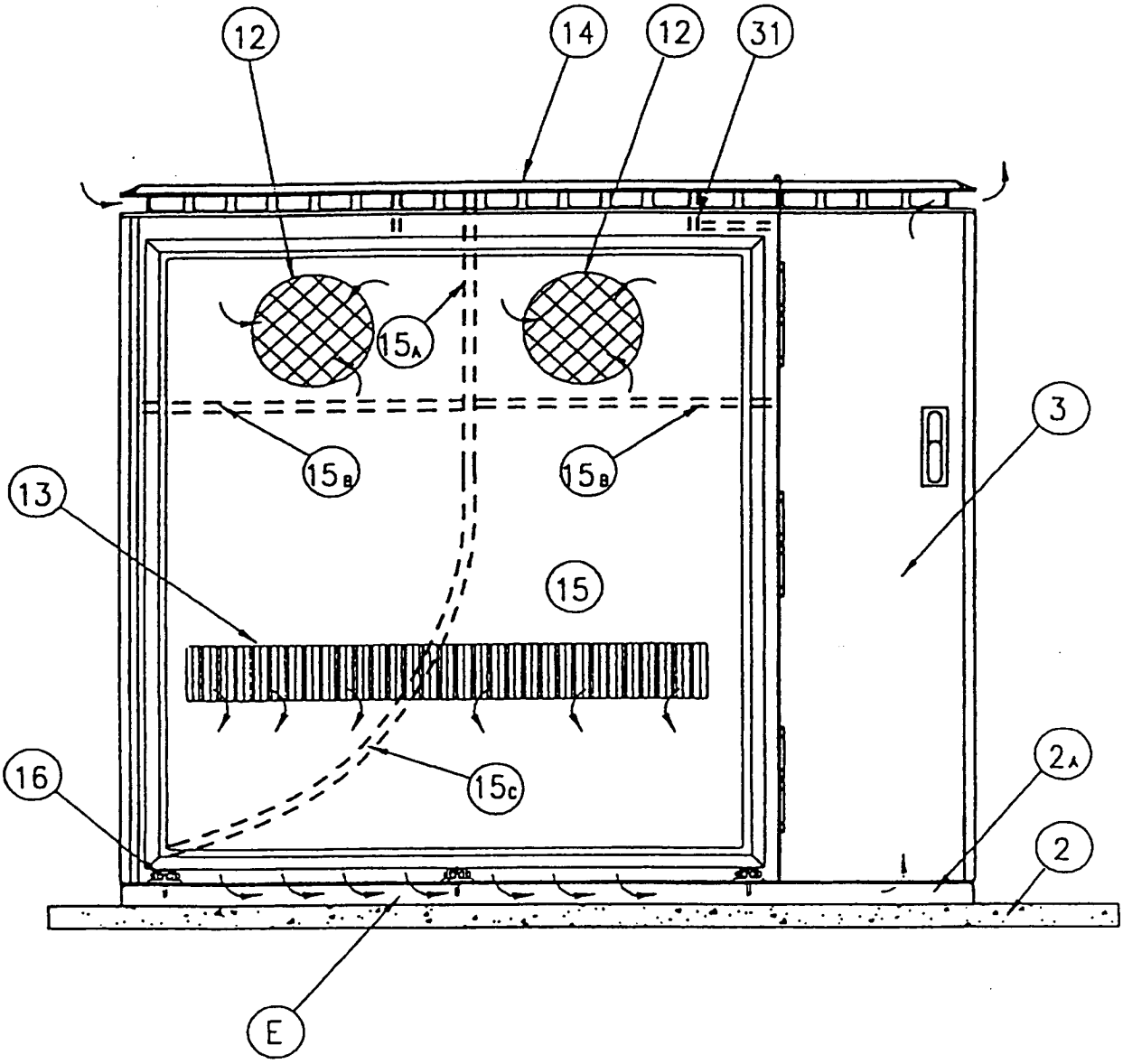


FIGURE 2

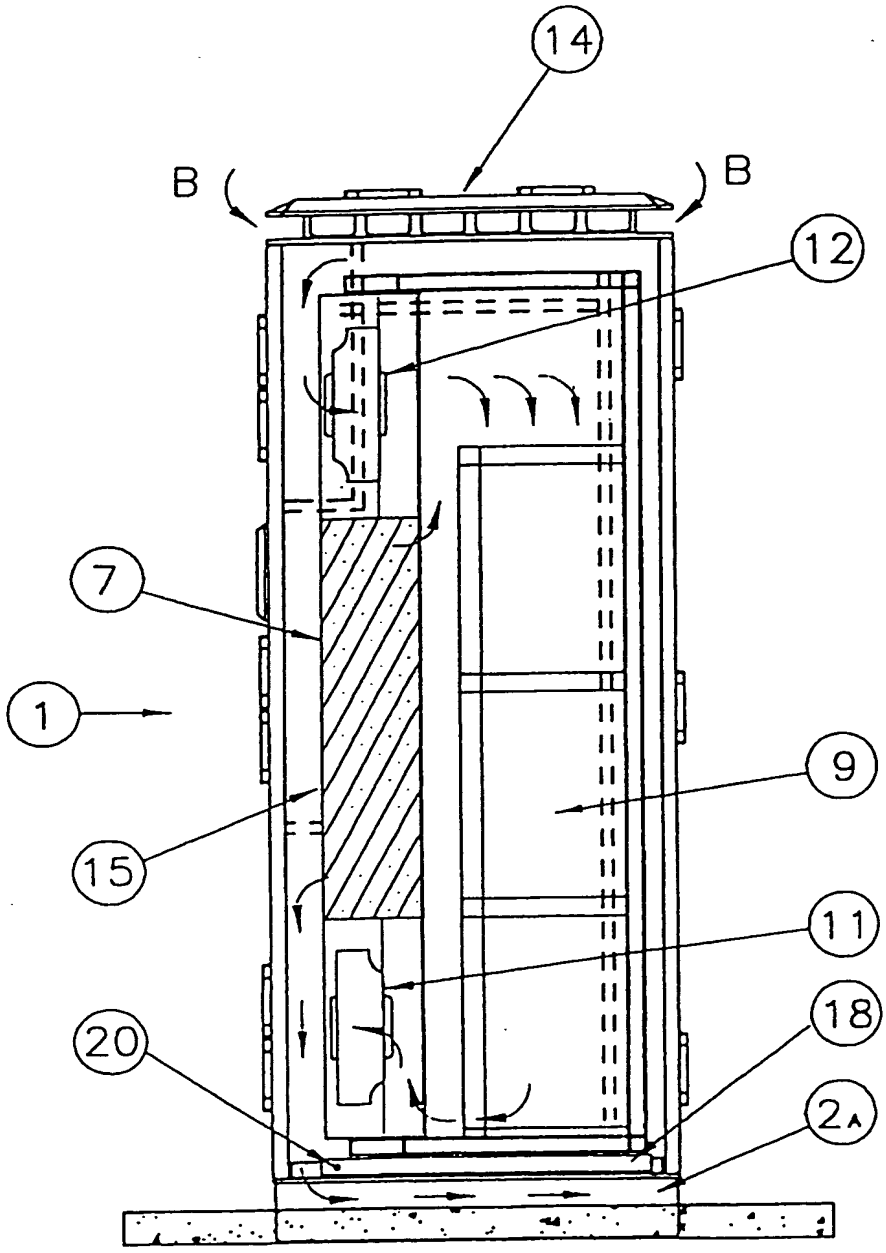


FIGURE 3

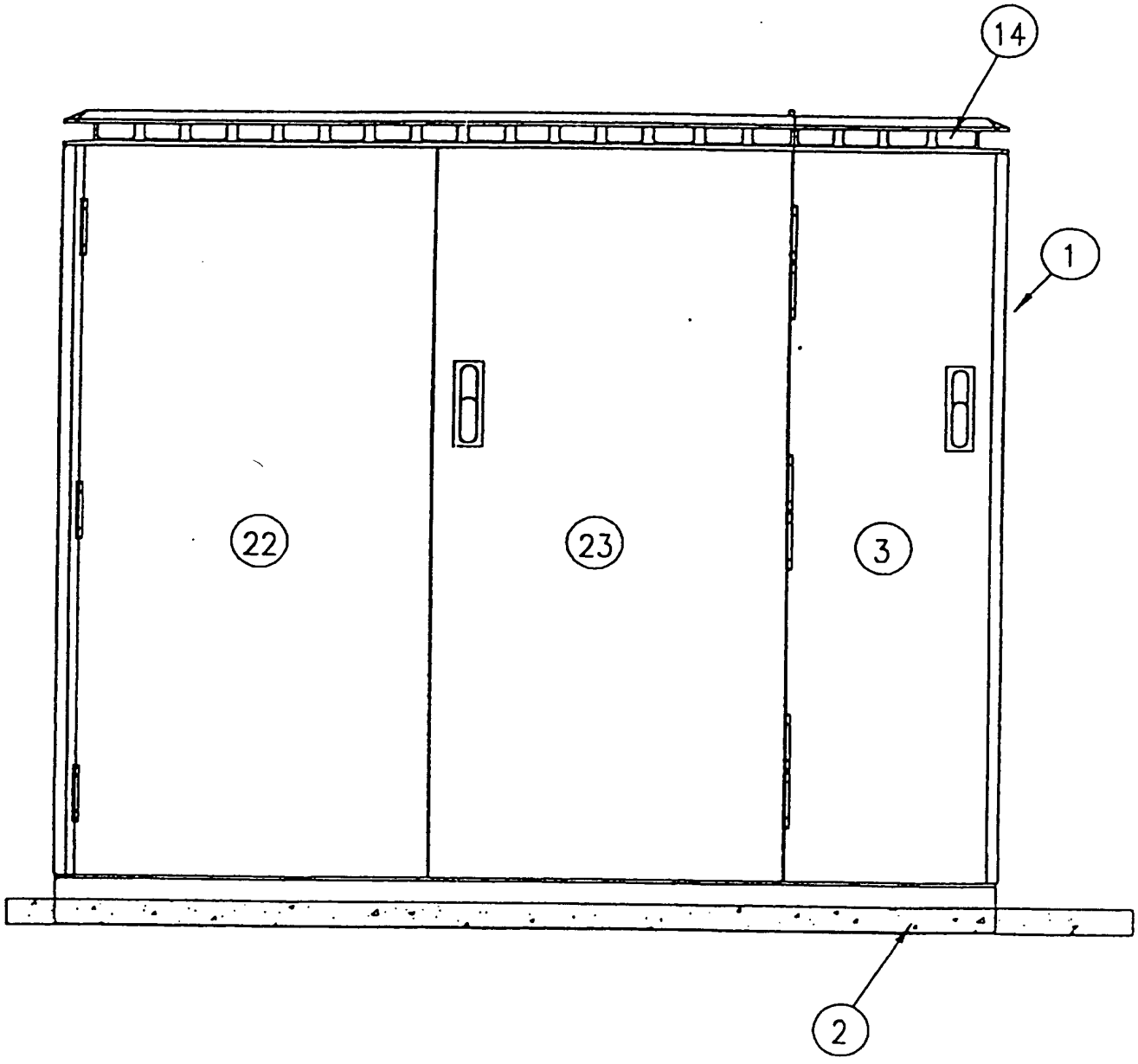


FIGURE 4

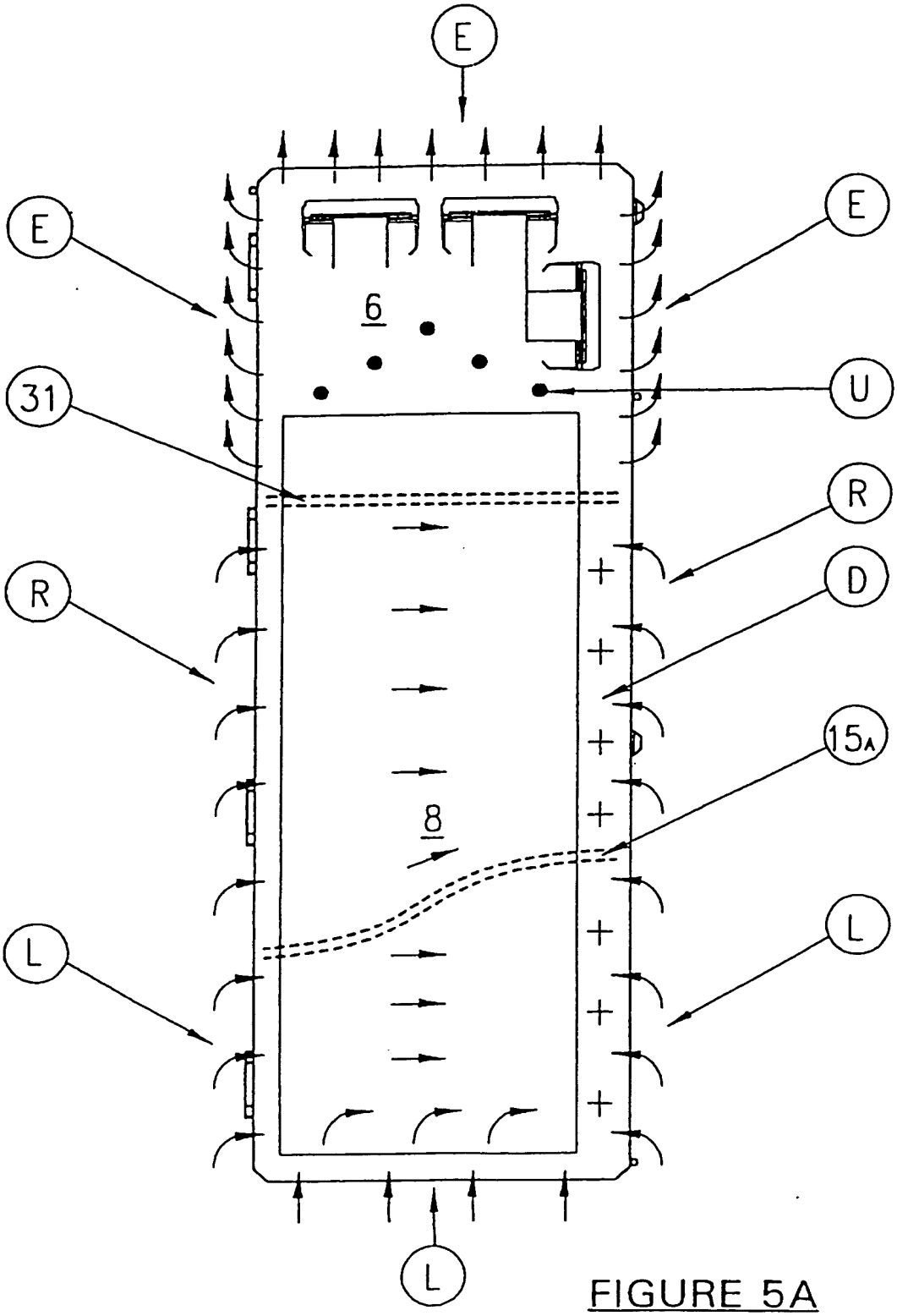


FIGURE 5A

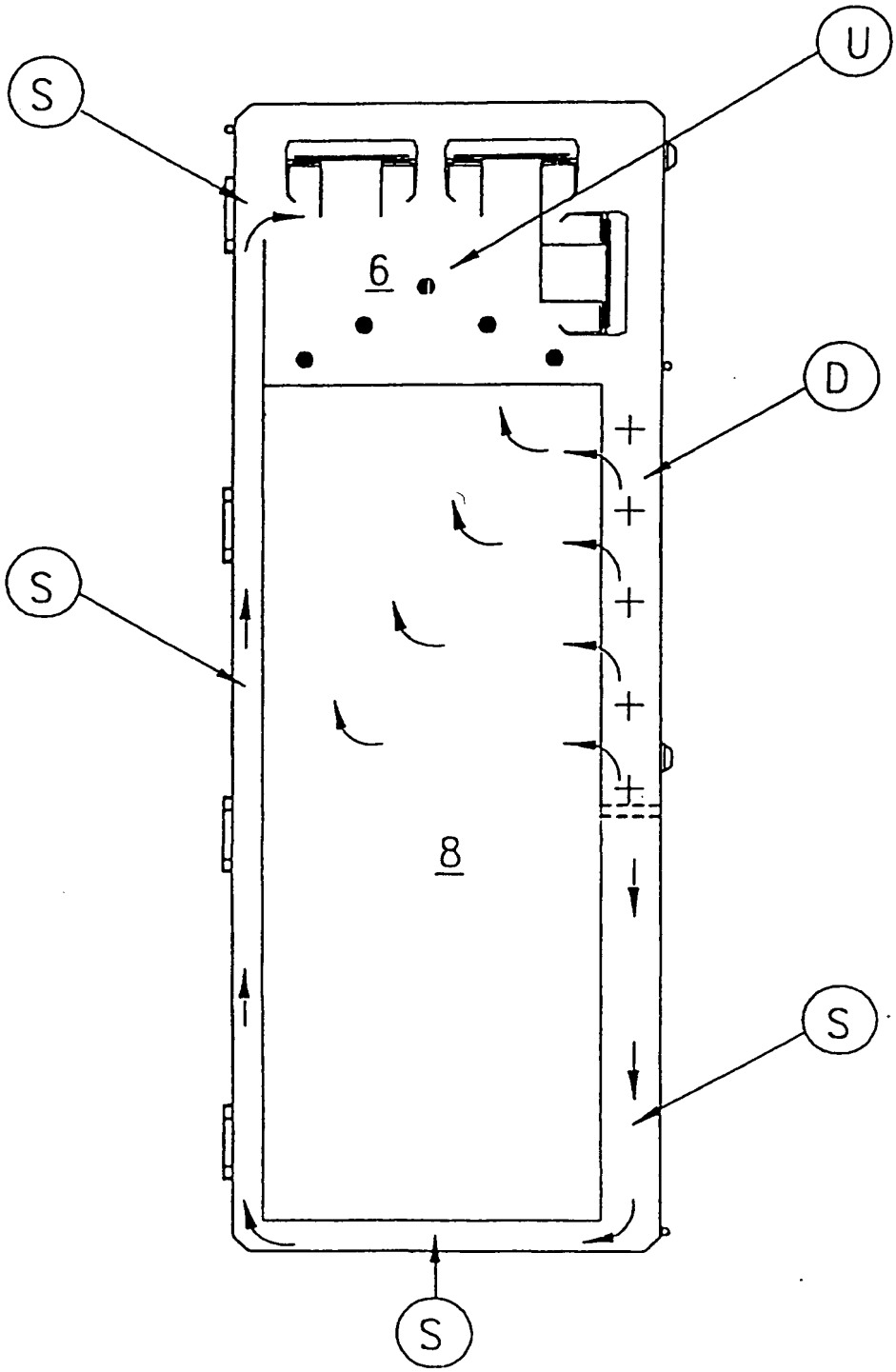


FIGURE 5B

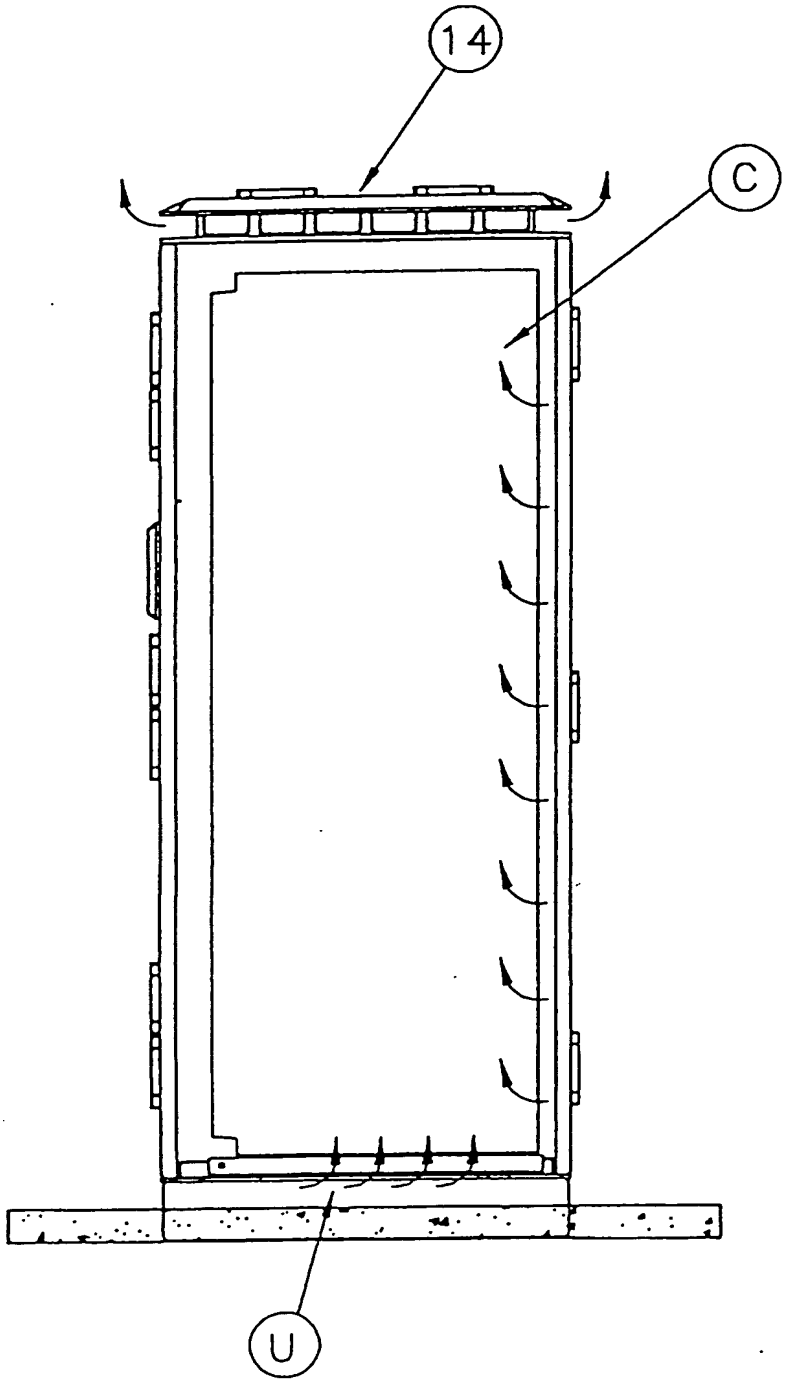


FIGURE 5C

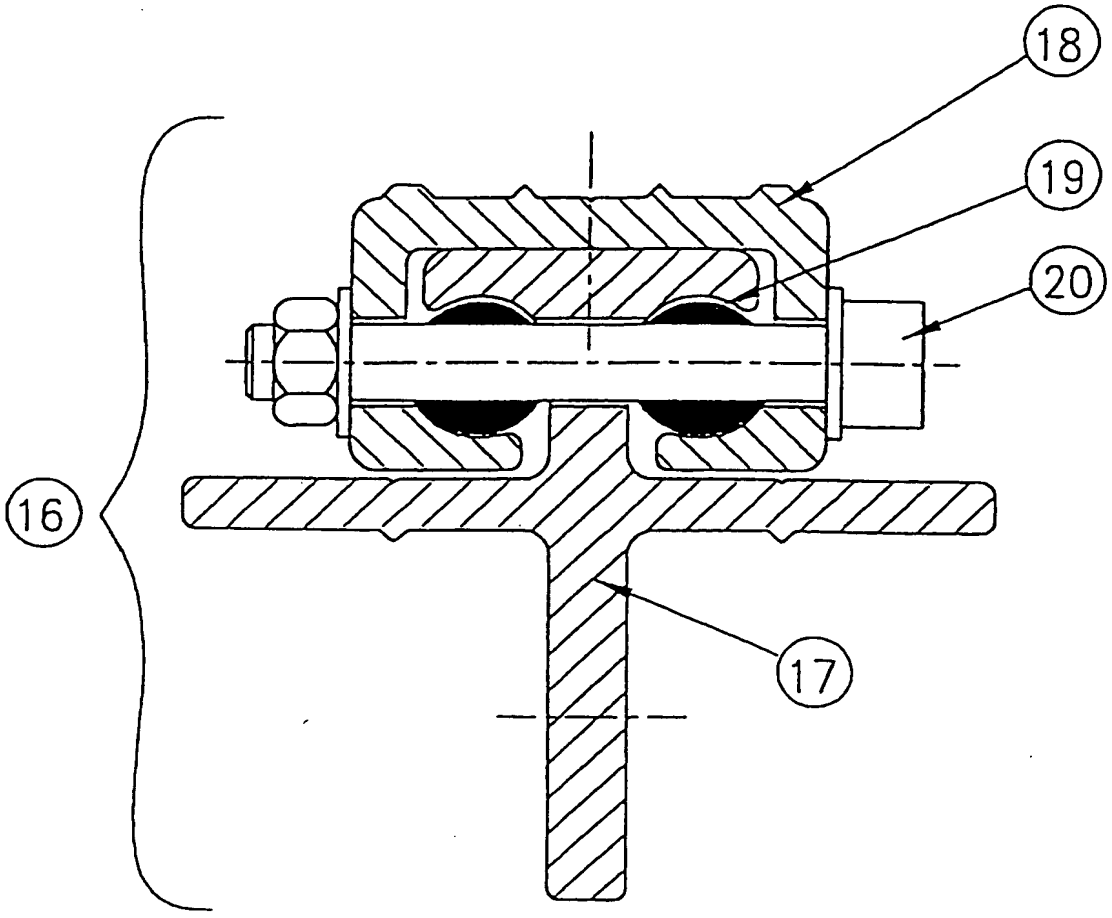


FIGURE 6

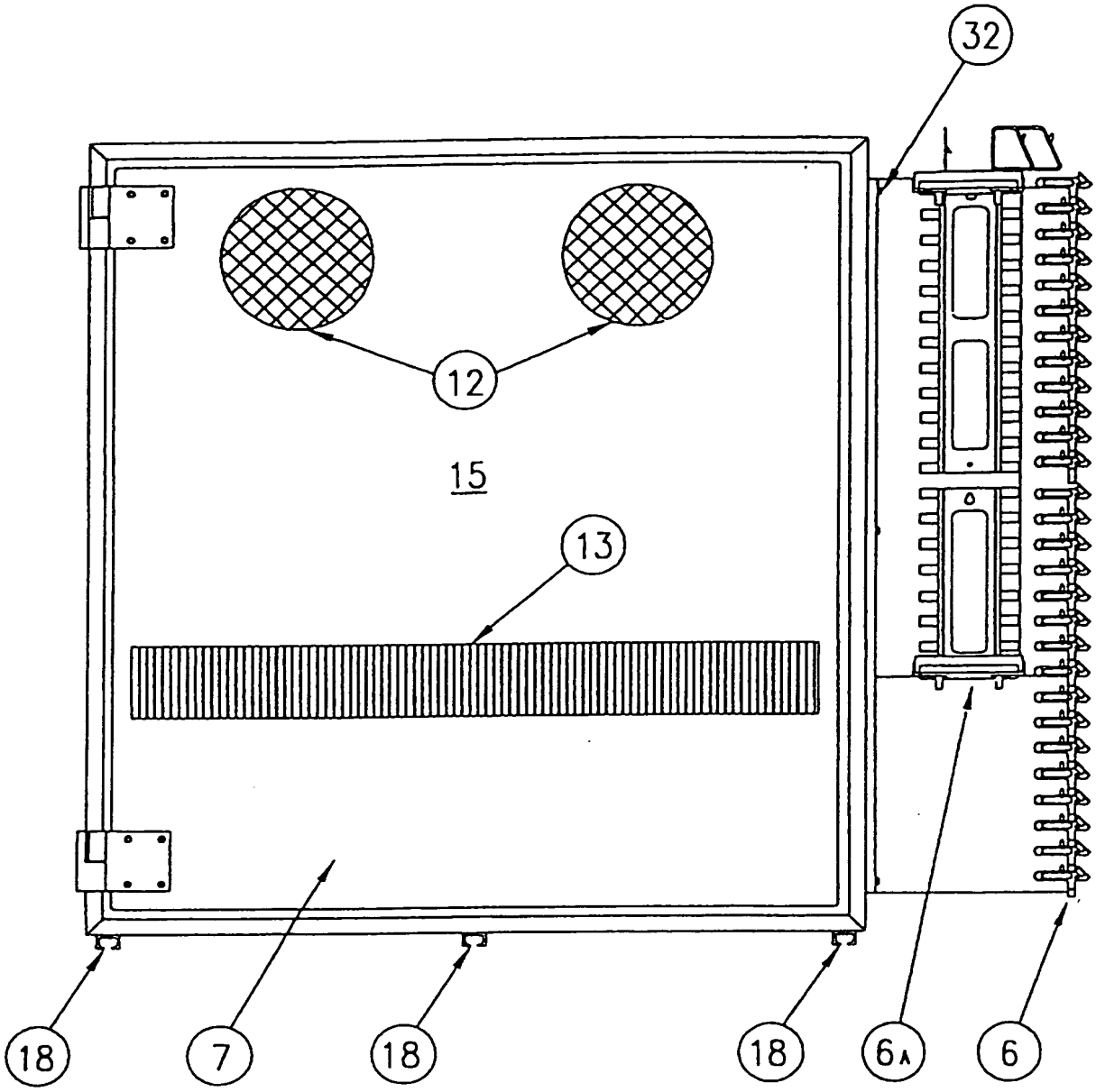


FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 97/00071

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: H05K 7/20, 5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : H05K 5/00, 5/02, 7/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT, JAPIO (COOL, FAN, VENTILATE, HEAT EXCHANGE, CHAMBER, ENCLOSURE, HOUSING)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	GB 2284659 A (MALCOE PRECISION FABRICATIONS) 14 June 1995 See page 3 line 35 to page 5 line 31	1-3, 7, 8, 13, 14
P,X	US 5467250 A (HOWARD) 14 November 1995 See column 4 line 59 to column 5 line 59	1-3, 7, 8, 13, 14
P,A	See column 8 lines 6 to 58, column 11 lines 9-30	9, 11
X	Patent Abstracts of Japan, E-1034, page 110, JP2-290109 A (MITSUBISHI ELECTRIC) 30 November 1990 See Abstract	1-3, 6, 7, 13, 14

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
6 August 1997

Date of mailing of the international search report
13 AUG 1997

Name and mailing address of the ISA/AU
AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION
PO BOX 200
WODEN ACT 2606
AUSTRALIA Facsimile No.: (06) 285 3929

Authorized officer

STEPHEN CLARK

Telephone No.: (06) 283 2164

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 97/00071

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5150277 A (BAINBRIDGE) 22 September 1992 See abstract and column 2 lines 25-64	1-14
A	US 5054545 A (GHAEMIAN) 8 October 1991 See column 3 line 26 to column 5 line 4	1-14
A	US 4386651 A (REINHARD) 7 June 1983 See Abstract, fig 1	1-14
A	Patent Abstracts of Japan, M-1465, page 18, JP5-99578 A (FANUC) 20 April 1993 See Abstract	1-14
A	Patent Abstracts of Japan, E-974, page 32, JP2-156698 A (FANUC) 15 June 1990 See Abstract	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/NZ 97/00071

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5150277	AU JP	75103/91 4271195	CA	2036164	EP	456398
US	5054545	CA	2055083				
US	4386651	AU JP	77889/81 57120088	DE	3045326	EP	57244

END OF ANNEX